BI-DIRECTIONAL ELECTRICAL TO OPTICAL CONVERTER MODULE

Cross-Reference to Related Application

This application claims the benefit of and priority from United States provisional application Serial No. 60/430,956 filed on December 4, 2002.

Background and Brief Summary of Invention

In storage area networks (SAN) redundant and resilient connections between servers, switches, and storage devices are necessary in order to ensure that a single point of failure in the network will not disrupt data flow from or to any node. SAN switches are becoming increasingly denser with respect to the number of connections coming out of the front panel. A conundrum exists in increasing this density with conventional approaches. In order to avoid excess cost due to additional boxes, a new smaller optical connector must be proposed. However, customers already feel the existing connectors are too small to be able to handle confidently. The invention herein doubles the number of connections that will fit on the front panel of a switch without requiring the redesign of an optical connector. The existing optical connectors are used, yet the port density is doubled. Furthermore, each connection has a built in redundant detector and laser, the components expected to fail first in the system.

A second embodiment of the invention provides a bi-directional module for use in residential applications.

A bi-directional (BiDi) transceiver module is described that contains a means for sending and receiving data through only one fiber. The BiDi transceiver module can be constructed to be either soldered directly or pluggable (removable) to the host unit (i.e. switch box). One or more electrical signals are transferred between the host unit and the BiDi transceiver module. Additionally, one or more optical signals are both transmitted and received from the BiDi transceiver module over an optical media (i.e. simplex multimode fiber) to another host unit. Two or more lasers are used along with one or more detectors. A negotiation process is used between two transceivers to determine which wavelength will be

used by which transceiver.

A primary object of the invention is to provide a BiDi transceiver module capable of simultaneously sending and receiving data through a single fiber.

A further object is to provide a transceiver module for use in storage area networks which utilizes existing optical connectors and which doubles the port density.

Another object is to provide a BiDi module for use in residential applications.

Other objects and advantages of the invention will become apparent from the following detailed description and drawings wherein:

Brief Description of the Drawings

Fig. 1 is a schematic representation of a BiDi transceiver having two lasers and two detectors, wherein the first laser T_1 and second detector R_2 are simultaneously transmitting and receiving and wherein the second laser T_2 and first receiver R_1 are turned off;

Fig. 2 is a schematic representation of the BiDi transceiver of Fig. 1 wherein second laser transmitter T_2 and receiver R_2 are in the on position and wherein the first laser T_1 and second receiver R_2 are in the off position;

Fig. 3 is a schematic representation of an embodiment showing the general case of n transmitting lasers and m receivers;

Fig. 4 is a schematic representation of the BiDi receiver module of Figs. 1 and 2 used in conjunction with an optical sub-assembly shown and described in U.S. patent 6,201,908; and

Fig. 5 is a schematic representation of an alternate embodiment of the invention adapted for use in residential applications.

Detailed Description of the Drawings

Figs. 1 and 2 illustrate a bi-directional transceiver shown generally as 110. Transceiver 110 includes an optical block 120 having a flat upper surface 121 and a flat lower surface 122. A reflective coating 130 is carried by the upper surface of optical block 120. A plurality of

filters 141, 142, 143 and 144 are carried on the flat lower surface 122 of optical block 120. Filters 141-144 are adapted to filter different wavelengths. In the embodiment shown in Figs. 1 and 2, filters 142 and 144 are designed to transmit light of wavelength λ_2 and filters 141 and 143 are designed to transmit light having wavelength λ_1.

Two beamsplitters 151 and 152 are attached to filters 143 and 144.

As shown in Fig. 1, a first transmitting laser T_1 transmitting an output beam with wavelength λ_1 is turned on and photodetector R_2 is turned on. In the configuration shown in Fig. 1, a second transmitting laser T_2 having an output beam of wavelength λ_2 is turned off and a first photodetector R_1 is turned off. The output beam of laser T_1 passes through beamsplitter 151, reflects off reflective surface 130, exits the optical block 120 at point 125 as shown by the arrows transmitting λ_1 light through a zigzag path in optical block 120 and outwardly to a single fiber optic cable 160. Simultaneously, transceiver 110 is receiving on the same zigzag optical pathway an input signal having wavelength λ_2 which enters optical block 120 at point 125 from cable 160. A portion of the incoming beam of wavelength λ_2 enters the splitter 152 and is essentially lost. The remainder of the beam continues the zigzag path shown by dotted lines and exits through filter 142 and impacts second photodetector R_2. The transceiver 110 is simultaneously transmitting a single channel and receiving a single channel through a single fiber optic cable 160.

Fig. 2 illustrates the redundancy aspect of optical transceiver 110 shown in Fig. 1 wherein the first transmitting laser T_1 is now turned off (if, for example, laser T_1 failed) and the second photodetector R_2 is turned off. In the configuration shown in Fig. 2, the second transmitting laser T_2 is turned on and transmits an output beam of wavelength λ_2. The first photodetector R_1 is turned on and receives an in-coming channel having wavelength λ_1. The output of transmitting laser T_2 passes through filter 144 and beamsplitter 152, is reflected off the reflectance layer 130 on the upper surface 121 of block 120 and exits block 120 at exit point 125 and passes into a single fiber optic cable 160. Simultaneously, the transceiver 110

is receiving a single channel of wavelength λ_1 that is transmitted through single fiber optic cable 160, passes through point 125 in the lower surface 122 of block 120 and is reflected along the zigzag path as shown by the arrows in Fig. 2 carrying the λ_1 input signal. As the λ_1 signal impacts splitter 151 half of the λ_1 signal is lost. The remaining portion of the signal continues down the zigzag pathway and exits through filter 141 and impacts the first photodetector R_1.

It is understood that the transceiver 110 shown in its simplest form in Figs. 1 and 2 may be extended to the general case in which the transceiver is capable of transmitting n channels and receiving m channels through a single fiber optic cable. The general case is illustrated schematically in Fig. 3 in which m transmitting lasers are illustrated each having a separate wavelength λ_1 through λ_n wherein each of the n lasers is optically aligned with one of the n beamsplitters. Similarly, a plurality of m photodetectors R_1 through R_m is optically aligned with one of the filters 241-240+m to separately filter said m different wavelengths. It is also possible to reduce the number of detectors and receive all signals on one detector. Reflections become an issue and both transmitted and reflected power levels must be strictly maintained to avoid cross talk issues.

Fig. 4 illustrates an optical block 20 which may be utilized in the present invention. The optical block 20 and related optics are shown and described in detail in U.S. patent 6,201,908, incorporated herein by reference. The '908 patent illustrates in detail how the optical block 20 is preferably coupled to a fiber optical receptacle through a collimating lens. Those optics are the preferred optics for use in conjunction with the present invention, although other optical pathways could be utilized. A detailed repetition of the description contained in the '908 patent is not made here in the interest of brevity.

Fig. 5 illustrates a second embodiment of the invention adapted for use in residential facilities. The primary difference in this embodiment from that shown in Figs. 1-3 is that no beamsplitters are utilized. In the embodiment shown in Fig. 5, the two transmitting lasers T_1

and T_2 transmit with output beams having wavelengths λ_1 and λ_2 and the receiving photo-detectors R_3 and R_4 receive signals transmitted into transceiver 210 at different wavelengths from the outputting lasers, i.e., at wavelengths λ_3 and λ_4. The transmitting of two channels and receiving of two channels occurs simultaneously. By utilizing different wavelengths, the use of 50-50 beamsplitters is avoided and costs are kept to the absolute minimum.

The foregoing description of the invention has been presented for purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications and variations of the above are possible in light of the above teaching. These particular embodiments were chosen and described to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art to best use the invention in various embodiments and with various modifications suited to the particular use contemplated. The scope of the invention is to be defined by the following claims.

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